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June 23, 2015

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VIA ELECTRONIC FILING

Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, N.W.
Washington, D.C. 20554

Re: Iridium Constellation LLC Petition for Rulemaking
RM-11697; RM-11685; IB Docket No. 13-213
Written Ex Parte Presentation

Dear Ms. Dortch:

Iridium Constellation LLC's ("Iridium") has documented an existing and future need for additional spectrum to provide important Big Low Earth Orbit ("Big LEO") Mobile Satellite Service ("MSS"). Over the past two years, Iridium has worked to address any legitimate concerns of Globalstar, Inc. ("Globalstar") to provide a "win-win" outcome for Big LEO MSS customers. Under Iridium's spectrum proposal, submitted in the above-captioned proceedings, the amount of 1.6 GHz spectrum currently shared by both companies would be expanded from 0.95 megahertz to 2.725 megahertz.[1] While a small and incremental increase, this added spectrum sharing will have profound benefits for Big LEO MSS customers.

Taken together, the pending Iridium and Globalstar requests are about the future of MSS in the Big LEO Band. Iridium's spectrum sharing proposal will make available additional spectrum to support continued MSS growth and innovation in the Big LEO Band, spectrum which Iridium can and will use immediately. Globalstar's TLPS proposal,[2] should it be granted, will lead to the creation of exclusion zones for Globalstar's duplex MSS operations across the country and

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[1] Letter from R. Michael Senkowski to Marlene H. Dortch, Secretary, Federal Communications Commission, RM-11685, RM-11697, IB Docket No. 13-213 (filed April 17, 2015) ("Iridium Spectrum Sharing Proposal"). Iridium currently shares 0.95 megahertz at 1617.775-1618.725 MHz with Globalstar. Under Iridium's new proposal, Globalstar and Iridium would share 2.725 megahertz at 1616-1618.725 MHz.

[2] *See* Terrestrial Use of the 2473-2495 MHz Band for Low-Power Mobile Broadband Networks; Amendments to Rules for the Ancillary Terrestrial Component of Mobile Satellite Service Systems, IB Docket No. 13-213, RM-11685, *Notice of Proposed Rulemaking*, 28 FCC Rcd 15351 (2013) ("TLPS NPRM"); Globalstar Inc., Petition for Rulemaking to Reform the Commission's Regulatory Framework for Terrestrial Use of the Big LEO MSS Band, RM-11685 (filed Nov. 13, 2012) ("Globalstar TLPS Petition").

evidences that company's lack of commitment to MSS. Globalstar's proposal would materially diminish the satellite resources available to first responders, critical industry, and consumers. While Iridium's proposal stands on its own merits, in light of the unique and essential role MSS plays in the nation's communications ecosystem, the Commission should grant no terrestrial relief to Globalstar without also granting Iridium's request for additional shared spectrum, securing the future availability and development of critical satellite services relied upon by a wide range of government, industrial, and commercial users.

The public interest basis for prompt and favorable action is supported by the record in these proceedings. The fully documented and undisputed facts before the Commission are as follows:

- Iridium needs additional spectrum to satisfy existing and future demands.[3]

- Iridium has no other option for securing additional spectrum except in the 1.6 GHz Big LEO MSS spectrum allocation.[4]

- Iridium's proposal would only expand the current sharing of 1.6 GHz Big LEO MSS spectrum and would not remove any spectrum from Globalstar.[5]

- Real world spectrum sharing by Iridium and Globalstar has proven to be workable and free from interference to Globalstar. This experience includes over seven years of shared access to 0.95 megahertz, in which Iridium currently operates on a daily basis. It also is based upon sharing under FCC-issued special temporary authority ("STA") for over a decade during times of simultaneous

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3 *See* Letter from Nancy J. Victory to Marlene H. Dortch, RM-11697, IB Docket No. 13-213, RM-11685 (Oct. 20, 2014) (*submitted pursuant to* Iridium Constellation LLC, Joint Protective Order, RM-11697, IB Docket No. 13-213, RM-11685, DA 14-1500 (rel. Oct. 16, 2014)) ("Iridium Oct. 20, 2014 Presentation").

4 *Id.*, Attachment at 26.

5 *See* Iridium Spectrum Sharing Proposal.

heavy usage by the two systems in the same areas without any documented harmful interference or effects to Globalstar.[6]

- Globalstar's system was designed to share its entire band with three other CDMA systems and sharing with Iridium's narrowband TDMA system in a small portion of its band presents less potential interference than a single CDMA system.[7]

- Iridium's technical analysis shows that the effects on Globalstar of expanded sharing with Iridium would produce interference levels that are significantly lower than Globalstar's own intra-system interference plus noise density.[8]

- Globalstar's engineering study using worst case assumptions shows less than a 0.5 dB increase in the noise-plus-interference level, which falls well below any level that can reasonably be viewed as cognizable harm by the Commission.[9]

- By its own admission, Globalstar's system capacity is constrained solely within the 2.4 GHz spectrum band, which is not implicated by Iridium's proposed expansion of 1.6 GHz spectrum sharing.[10]

- The concerns about Globalstar's increased use of lower 1.6 GHz channels causing interference to the radioastronomy service ("RAS")

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[6] Letter from R. Michael Senkowski to Marlene H. Dortch, Secretary, Federal Communications Commission at 5-7, RM-11685, RM-11697, IB Docket No. 13-213 (filed Feb.5, 2015) ("Iridium Feb. 5, 2015 Letter"); Supplemental Comments of Iridium Constellation LLC at 6-9, RM-11697, IB Docket No. 13-213, RM-11685 (filed Nov. 5, 2014) ("Iridium Nov. 5, 2014 Supplemental Comments").

[7] Iridium Nov. 5, 2014 Supplemental Comments at Exhibit 2.

[8] *Id.*

[9] *See* Roberson and Associates, Reply to Iridium Ex Parte at 5 (dated May 14, 2015) ("Roberson May 14, 2015 Reply") *attached to* Letter from Regina M. Keeney to Marlene H. Dortch, Secretary, Federal Communications Commission, RM-11697 (filed May 14, 2015) ("Globalstar May 14, 2015 Letter").

[10] Globalstar, L.P., *Description of the Globalstar System* at 4-14, GS-TR-94-0001 Revision E (Dec. 7, 200) *available at* https://gsproductsupport.files.wordpress.com/2009/04/description-of-the-globalstar-system-gs-tr-94-0001-rev-e-2000-12-07.pdf ("Globalstar System Description).

were eliminated when Iridium withdrew its exclusive spectrum request. Iridium will address future RAS concerns about its operations in the context of its next-generation satellite system, Iridium NEXT.[11]

- Globalstar's TLPS proposal contemplates nationwide offering of a terrestrial wireless broadband system that will preclude Globalstar's two-way MSS operations everywhere it is deployed.[12]

In light of this record, the Commission should grant Iridium the additional shared spectrum access requested in its April 17 filing, either independently or in conjunction with action on Globalstar's Terrestrial Low Power Service ("TLPS") proposal.[13]

I. IRIDIUM HAS FULLY DOCUMENTED ITS SPECTRUM NEEDS AND CONTINUES TO INTRODUCE NEW SERVICES THAT WILL FUTHER DRIVE DEMAND.

Iridium's request for additional spectrum will allow it to continue introducing innovative new MSS capabilities and meet the needs of its growing population of users. Iridium serves its entire global customer base on less than nine megahertz of unpaired spectrum while Globalstar enjoys over 25 megahertz of paired spectrum. Despite its limited spectrum, Iridium currently offers a truly global system relied upon by the U.S. government, public safety, emergency responders, the energy and transportation industries, the maritime and aviation sectors, scientific researchers, and other diverse commercial and individual users for their critical communications needs. With the pending launch of Iridium's next generation system, Iridium NEXT, Iridium will develop exciting satellite solutions that provide unique and novel communications capability to customers and industry partners.

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11 *See* Iridium Spectrum Sharing Proposal at 5-6.

12 *See* Globalstar TLPS Petition at 29-30 (recognizing that MSS exclusion zones will result from the deployment of TLPS); *see also* Comments of Globalstar, Inc. at 21, IB Docket No. 13-213, RM-11685 (filed May 5, 2014) (acknowledging TLPS interference to MSS) ("Globalstar TLPS Comments"); *id.* at 11 (proposing to deploy "hundreds of thousands or even millions" of TLPS access points).

13 *See* TLPS NPRM; Globalstar TLPS Petition.

Iridium has irrefutably demonstrated its need for additional MSS spectrum and its ability to put that spectrum immediately to use to serve the public. From the beginning of this proceeding, Iridium detailed the wide range of critical communications applications it supports around the world on its extremely efficient satellite system, using only 8.725 MHz of spectrum.[14] Last October, Iridium presented a detailed showing under Joint Protective Order documenting that its voice and data usage has grown significantly since 2007.[15] Iridium's subscribers have tripled since that time, and its minutes of use and other metrics have increased significantly as well. Iridium's need for spectrum is driven by the success of the company at developing and bringing to market reliable, advanced, mobile satellite solutions tailored to its customers' critical communications needs. And Iridium's spectrum needs are not diminishing: new products and service offerings being developed in conjunction with Iridium NEXT will further drive demand on Iridium's system.

One such offering is Iridium Certus[SM], which will leverage the enhanced infrastructure, capacity, and capabilities of Iridium NEXT to deliver reliable, versatile enterprise-grade mobile satellite broadband communications.[16] Iridium has partnered with five industry-leading manufacturers to provide Iridium's next-generation broadband services through Iridium Certus[SM], which is expected to be available as soon as late 2016. When Iridium NEXT is fully deployed, Iridium Certus[SM] is expected to support a portfolio of products with a broad range of data speeds eventually as high as 1.4 megabits per second and to support a wide range of products designed to meet diverse aviation, maritime, and land mobile communication needs.

Alongside Iridium's existing voice and data solutions, new offerings like Iridium Certus[SM] are expected to increase demand on Iridium's network resources. Iridium's current and next generation satellite systems are capable of delivering MSS across the 1616-1626.5 MHz portion of the 1.6 GHz Big LEO MSS band. Iridium has already confirmed to the Commission that it has fully integrated and heavily uses all of the currently shared spectrum consistent with its

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[14] *See, e.g.*, Reply of Iridium Constellation LLC at 2-9, RM-11697, RM-11685, IB Docket No. 13-213 (filed Dec. 17, 2013).

[15] Iridium Oct. 20, 2014 Presentation.

[16] *See* Iridium, *Iridium Certus[SM] Broadband*, https://www.iridium.com/about/IndustryLeadership/Iridium-Certus-Broadband.aspx (last visited June 3, 2015).

channelization.[17] With Iridium NEXT satellites scheduled to begin launch later this year, the 1.775 megahertz at 1616-1617.775 MHz is the only additional spectrum available for Iridium's MSS use for the next 15-20 years.

II. IRIDIUM'S SHARING PROPOSAL IS BASED ON REAL WORLD EXPERIENCE AND CONSISTENT WITH THE ENGINEERING ANALYSES OF BOTH IRIDIUM AND GLOBALSTAR CONSULTANTS.

Iridium's spectrum sharing proposal is an opportunity to make additional spectrum available for Big LEO MSS without hindering incumbent operations. Real world experience shows that there are no resulting harms to Globalstar from spectrum sharing with Iridium and there is no real world evidence or fact-based technical analyses in the record demonstrating an increase in harmful interference as a result of Iridium's proposal. In contrast, Iridium has provided detailed technical analysis, based on the actual design and performance of the Iridium and Globalstar satellite systems, demonstrating the viability of its proposal.

As a result, the record before the Commission now shows the following: (1) there have been no interference problems reported during seven years of co-primary shared access to 0.95 MHz spectrum and periodic sharing between Iridium and Globalstar pursuant to STA during times of peak use by both systems in the same geographic areas dating back over 10 years; (2) Globalstar's CDMA system was designed to share with three other CDMA systems and Iridium's TDMA system presents less interference potential than would have occurred if even one of those other CDMA systems had commenced service; and (3) multiple rounds of engineering analysis by both Iridium and Globalstar show no harmful interference, even under worst case scenario conditions. In light of this record, the Commission should conclude that expanded sharing provides a compelling public interest benefit without generating any harms.

A. Real World Experience and Globalstar's System Design Support Expanded Sharing.

As Iridium has stated previously, there is no need to rely upon theoretical analyses of the potential for interference between the two systems (although, as explained below, even these analysis fail to show any harmful interference to Globalstar).

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[17] Iridium Nov. 5, 2014 Supplemental Comments at 4, Exhibit 1.

Globalstar and Iridium have shared spectrum successfully in the real world for years with no complaints of harmful interference or negative impacts on Globalstar's system capacity. This sharing has included the prolonged sharing of 0.95 MHz of spectrum, which currently is used on a daily basis across Iridium's global footprint consistent with its channelization.[18] It also includes extraordinary cases of shared use across wider portions of the band in times of peak demand during emergencies, pursuant to STA. Were there any basis for Globalstar's concerns about harmful effects on its system due to sharing with Iridium, certainly it would have evidence of this harm based on the previous sharing by the operators. Globalstar's failure to offer such evidence alone would be telling, however, Globalstar has gone further and verified on the record that not only has it "not experienced any quality of service issues due to this sharing," but it has been unable even to detect Iridium's use of the shared band in North America.[19]

This lack of evidence of interference should not be surprising, as CDMA systems like Globalstar's are designed to operate in shared environments. The Big LEO MSS band was always intended to be a home to four CDMA systems and one TDMA system. As Iridium demonstrated in its November 5, 2014 supplemental comments, increasing spectrum sharing with Iridium in a small portion of Globalstar's overall band would pose a significantly lower risk of harmful interference than would sharing with even one other CDMA operator across the entirety of the band, let alone the three other operators originally intended. Iridium's analysis demonstrated that the aggregate Iridium terminal uplink interference is 6.4 dB less than what would be expected from another hypothetical CDMA system and 11.2 dB less than the aggregate interference from three other CDMA systems.[20] Globalstar's claim that sharing less than two additional megahertz of spectrum with Iridium would cause it serious harm when Iridium interferes less than even a single of the three CDMA systems with which Globalstar's system was designed to share its entire band lacks all credibility.

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18 *See* Iridium Nov. 5, 2014 Supplemental Comments at Exhibit 1.

19 Letter from L. Barbee Ponder IV, General Counsel & Vice President Regulatory Affairs, Globalstar, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission at 7 n. 18, RM-11697 (filed Oct. 24, 2014) ("Globalstar Oct. 24 Letter").

20 Iridium Nov. 5, 2014 Supplemental Comments, Exhibit 2 at 5.

B. Globalstar's Technical Analyses Do Not Show Any Cognizable Harm from Iridium's Spectrum Sharing Proposal.

On May 14, 2015, Globalstar filed a response to Iridium's spectrum sharing proposal that included a technical appendix developed by Roberson and Associates.[21] As detailed in the technical analysis Iridium's engineering consultant, Harris Corporation, appended to this letter,[22] Globalstar's latest analysis again fails to demonstrate actual evidence of harmful interference caused by Iridium's current or proposed operations. Instead, the May 14 filing again relies upon an academic analysis using unrealistic assumptions and ignoring key facts about the design and operating environment of Globalstar's system that still fails to make a compelling case to reject Iridium's proposal. Globalstar makes two main technical claims in its latest filing: first, that expanded sharing with Iridium will cause unacceptable harmful interference to Globalstar's operations, and second, that expanded sharing will severely limit Globalstar's per-satellite capacity. Each of these claims is incorrect.

On the question of harmful interference, Globalstar again uses unrealistic assumptions regarding traffic loading on Iridium's network in conducting its interference analysis. However, even if one accepts Globalstar's assumptions (which Iridium does not), the company has still failed to allege any interference-based impact that could remotely be characterized as harmful interference. Globalstar's revised analysis concludes that expanded sharing with Iridium would result in an 11.9% increase in noise-plus-interference in the shared spectrum. This 11.9% increase in noise-plus-interference equates to a degradation of 0.5 dB within 2.725 megahertz of shared spectrum out of Globalstar's more than 25 megahertz of service link spectrum[23]—an impact that would be undetectable from a user's perspective. Indeed, MSS received signal levels can vary more than this amount each second under normal conditions.[24]

Recognizing a 0.5 dB increase in noise-plus-interference as an appropriate metric for harmful interference would be unprecedented, and could have ramifications far beyond the instant proceeding. If this minute increase in interference can be

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21 Globalstar May 14, 2015 Letter.

22 *See* Technical Appendix, *infra.*

23 *See infra* Technical Appendix at 2; Roberson May 14, 2015 Reply at 5.

24 *See infra* Technical Appendix at 2.

considered "harmful" in a simple scenario with only two operators sharing a small part of larger band, there would seem to be little chance of success for more complex spectrum sharing and repurposing scenarios currently under consideration or development, such as in the 600 MHz Band,[25] in the newly created Citizens Broadband Radio Service ("CBRS"),[26] or even Globalstar's own proposal for sharing between TLPS and 2.4 GHz unlicensed operations.[27] To Iridium's knowledge, the Commission has never suggested that such a miniscule rise in interference should be considered "harmful." Indeed, in 2007 the Commission described a similar amount of degradation—0.4 dB—as having a "negligible" effect on satellite receivers.[28] Moreover, Iridium believes the true interference impact of its proposal to be closer to 0.1 dB in any event.[29]

In addition to its baseless claims of harmful interference, Globalstar also revised and reiterates its assertion that expanded sharing with Iridium will degrade its system capacity. Again, however, Globalstar builds its analysis on unrealistic loading assumptions to reach a conclusion that is at odds with the real-world experience of sharing in this band. Globalstar's capacity argument, as stated, assumes maximum loading of Iridium's system simultaneously across a land area the size of the continental United States and Mexico, with traffic spread evenly throughout its entire authorized spectrum band.[30] This would be an unprecedented and unsupportable loading scenario. A more realistic heavy-loading scenario might consider maximum Iridium loading in a localized area—such as the site of a major disaster. As detailed in the Technical Appendix to this filing, using more realistic heavy-loading assumptions, and otherwise applying (without endorsing) Roberson's methodology, leads to a conclusion that even under peak loading conditions during disasters stretching across areas of hundreds of thousands of square miles, the total

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25 *See* Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, ET Docket No. 14-165, *Notice of Proposed Rulemaking*, 29 FCC Rcd 12248 (2014).

26 *See* Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959 (2014).

27 *See* TLPS NPRM.

28 Wireless Operations in the 3650-3700 MHz Band, ET Docket No. 04-151, *Memorandum Opinion and Order*, 22 FCC Rcd 10421, 10441 ¶ 51 (2007).

29 Iridium Nov. 5, 2014 Supplemental Comments, Exhibit 2 at 5.

30 *See* Iridium Feb. 5, 2015 Letter at 10-11; *id.*, Technical Appendix at 4.

capacity of a single Globalstar satellite would be reduced by less than two percent. Thus, Globalstar has, at best, illustrated the potential for fleeting impacts on its system capacity, in geographically localized areas, and only under unrealistic, worst-case circumstances. Yet, unlike Iridium, which has demonstrated its need for and ability to use additional spectrum, Globalstar has never suggested that it uses anywhere near all of system capacity now or has plans to do so in the future.

Globalstar's interference and capacity arguments also ignore key facts that further undermine their credibility. First, Globalstar's technical analysis ignores the actual design of Globalstar's system, in which nearly all of its global coverage area is covered by multiple satellites, including all of the continental United States. Multi-satellite diversity and coverage both makes additional capacity available and provides diversity and mitigation against external interference. These factors undermine and rebut Globalstar's assumptions concerning effects on capacity that additional spectrum sharing would represent. Second, Globalstar acknowledges that its system capacity is limited on the 2.4 GHz/S-Band side, not the 1.6 GHz return link,[31] therefore the discussion about impacts on its 1.6 GHz capacity are inapposite. This is further illustrated by the fact that Globalstar only uses one uplink channel in most of its gateway Earth stations.[32] Were capacity or usage level an issue, presumably Globalstar would utilize more than one channel. Third, and relatedly, Globalstar's capacity assumptions are based on its duplex service, but its predominant commercial offering is its simplex SPOT service, for which its satellites should have a much greater capacity, as SPOT terminal emissions are lower power than voice terminals, short in duration, benefit from greater processing gain, and reside in frequency channels that are adjacent to the voice channels. Whatever the impact on Globalstar's duplex capacity caused by expanded sharing with Iridium, the impact on its simplex services would certainly be less.

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[31] "In the forward direction,…this is the direction that constrains capacity." Globalstar System Description at 4-14.

[32] Letter from L. Barbee Ponder IV, General Counsel & Vice President Regulatory Affairs, Globalstar, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission, Attachment at 16, RM-11697 (filed Oct. 6, 2014) (showing only one uplink channel being used in 13 of 24 Globalstar gateways) ("Globalstar Oct. 6 Letter").

C. Iridium Continues to Take Great Efforts to Protect Radioastronomy Services.

Iridium's spectrum sharing proposal addresses Globalstar's arguments related to protection of the radio astronomy service ("RAS"). Previously parties had asserted that without access to some of the higher channels in the 1.6 GHz band, Globalstar would be unable to provide sufficient protection to RAS operations without also suffering severe capacity limitations.[33] Iridium's spectrum sharing proposal fully resolves this concern. Under the sharing proposal, Globalstar will maintain access to all spectrum it has access to today. There need be no effect on RAS due to changes in Globalstar's operations.

Iridium has also taken and continues to take substantial efforts to address RAS concerns about its own operations. Iridium has had mutual coordination agreements with radio astronomers in the U.S. since beginning operations in 1998. Iridium also engages with representatives for the RAS observatories in the U.S. and abroad to discuss Iridium NEXT-RAS interaction. Iridium has proposed an RAS Protection Program, through which Iridium would adjust the operational characteristics of its system to provide protection to RAS observations at specific observatories, with advance notice. Iridium's efforts to accommodate RAS are the subject of ongoing engineering, analysis, and coordination.[34]

D. Iridium's Proposal is Consistent with and Reinforced by the Globalstar's TLPS Proposal.

It is ironic that Globalstar would object so strongly to Iridium's proposal to share less than two additional megahertz when its own TLPS proposal is built upon a presumption that sharing can work effectively among diverse services across a wide range of spectrum. Globalstar's TLPS proposal contemplates managed TLPS, unlicensed Wi-Fi and Bluetooth, licensed MSS, and grandfathered Broadcast Auxiliary Service ("BAS") operations—each service with its own distinct operational and deployment characteristics—sharing the same spectrum band through coordination, cooperation, and technical interference mitigation. By

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[33] *See* Globalstar Oct. 24 Letter at 5-6; Letter from Harvey S. Liszt, National Radio Astronomy Observatory to Marlene H. Dortch, Secretary, Federal Communications Commission, RM-11697 (filed Oct. 21, 2014).

[34] *See* Letter from Jennifer D. Hindin to Marlene H. Dortch, Secretary, Federal Communications Commission, IBFS File No. SAT-MOD-20131227-00148 (filed June 3, 2015).

contrast, Iridium's spectrum sharing proposal would have two MSS operators share less than three megahertz of spectrum in a band originally intended to be inhabited by five such operators. In this sense, Iridium's proposed spectrum sharing is philosophically entirely consistent with (though far less extreme than) Globalstar's own proposal.

Iridium has never taken a position on the merits of the TLPS proposal and through its needs showings and technical analyses it has demonstrated that grant of its proposal would serve the public interest irrespective of any action the Commission might take with respect to the pending TLPS NPRM. However, the TLPS proposal, if granted, strongly reinforces the need for Iridium's proposal, due to the decrease in MSS capacity contemplated by Globalstar through its TLPS deployment plans. An essential part of the TLPS proposal is elimination of any obligation for Globalstar to continue offering Big LEO MSS on any substantial basis.[35] Globalstar has acknowledged on the record that wherever TLPS access points are deployed, there will be exclusion zones that preclude providing its duplex MSS at such locations.[36] Although Globalstar has suggested that MSS is not needed in metropolitan areas and that TLPS will be restricted to metropolitan areas,[37] Iridium's experience has been that reliable MSS performance is essential in metropolitan areas, particularly in the wake of disasters.[38] Globalstar has published maps evidencing its intention to deploy TLPS across the country as opposed to just in urban markets,[39] reinforced by

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35 Globalstar TLPS Petition at 30-31.

36 *See id.* at 29-30 (recognizing that MSS exclusion zones will result from the deployment of TLPS); *see also* Globalstar TLPS Comments at 21 (describing the need to terminate TLPS to prevent MSS interference) ("Globalstar TLPS Comments").

37 *See* Letter from L. Barbee Ponder IV, General Counsel & Vice President Regulatory Affairs, Globalstar, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission at 2, IB Docket No. 12-213, RM-11685, RM-11697 (filed Oct. 6, 2014).

38 *See* Letter from R. Michael Senkowski to Marlene H. Dortch, Secretary, Federal Communications Commission, Attachment C, RM-11697, IB Docket No. 13-213, RM-11685 (filed Oct. 16, 2014) (illustrating increase in demand for Iridium's satellite services following Superstorm Sandy) ("Iridium Oct. 16, 2014 Letter").

39 *See* Globalstar, Response to Kerrisdale Capital Presentation, http://www.globalstar.com/en/index.php?cid=6350 (Oct. 9, 2014); *see also* Iridium Oct. 16, 2014 Letter.

its stated plan to deploy "hundreds of thousands or even millions" of TLPS access points.[40]

If its TLPS proposal is adopted, Globalstar will aggressively and logically deploy its terrestrial service across the country. In so doing, Globalstar will inherently and inevitably constrain and diminish its MSS duplex business. By essentially eliminating any incentive for Globalstar to expand its duplex MSS customer base (or any marketability of its duplex services), Globalstar's TLPS proposal, if granted, will cement Globalstar's future as a terrestrial-first, satellite-second-or-not-at-all network operator. As satellite services are impaired in the course of Globalstar's transition to terrestrial service, Globalstar will have a concomitant reduction in its need for 1.6 GHz Lower Big LEO band spectrum, which is used only in service of its satellite business. Not only will this decrease in service availability on Globalstar's system drive further adoption of Iridium's services, it also renders nonsensical any complaints about harmful interference to Globalstar's MSS operations caused by expanded sharing with Iridium. Therefore, while Iridium's spectrum sharing proposal stands on its own merits, the Commission should not grant Globalstar expanded terrestrial authority without also acting favorably on Iridium's request.

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Iridium's request for additional Big LEO Band MSS spectrum has now been pending for over two years. In that time, Iridium has demonstrated its need for additional spectrum to support it current and future MSS operations, its ability to put the additional spectrum to use immediately to serve the public interest, that spectrum sharing has caused no harmful interference to Globalstar, and that increased spectrum sharing would cause no harm to Globalstar. It has demonstrated these facts through the submission of real world evidence and technical analyses based on the actual experience and the design and capabilities of the systems operating in the band. During the pendency of this proceeding, Iridium has continued to innovate and grow its MSS business. Iridium has moved forward with the development of new products and services, both for its current constellation and for its next generation system, Iridium NEXT, which only underscore the public interest benefits of Iridium's request.

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[40] Globalstar TLPS Comments at 11.

Iridium's spectrum sharing proposal is a reasonable approach to promoting the growth and development of MSS in the Big LEO Band without harming other services. Iridium has made the case for grant of its proposal. Iridium's spectrum sharing request makes sense today, and is compatible with current and future satellite operations by both Iridium and Globalstar. And, should Globalstar receive the additional terrestrial flexibility it has requested, the case for Iridium's request becomes even stronger. Here, faced with a voluminous and compelling record in support of Iridium's proposal, the Commission should take the logical response of granting Iridium's request, and moving forward with the modest increase in 1.6 GHz Big LEO MSS spectrum sharing proposed by Iridium, either on its own or in conjunction with action on Globalstar's TLPS proposal.

Respectfully Submitted,

/s/ R. Michael Senkowski

R. Michael Senkowski

Technical Appendix
Prepared by: Brandon Hinton, Consultant to Iridium and
Senior Principal Systems Architect Engineer, Harris Corp.

Reply to Report of Roberson and Associates, LLC, *Response to Iridium Ex Parte,* May 14, 2015

1. Background

Roberson and Associates recently submitted an appendix (*Response to Iridium Ex Parte*[1]) to Globalstar's May 14 filing, which responded to Iridium's previous filing and also refined some previous analyses from Roberson. This Technical Appendix responds to Roberson's academic arguments and continued claims of potential for harmful interference from Iridium as part of Iridium's band sharing proposal.

Iridium strongly disagrees with any assertion that additional sharing between Iridium and Globalstar in the 1616.0-1617.775 MHz band will produce harmful interference to Globalstar and believes there is no precedent for precluding additional spectrum sharing based on such a minimal interference impact.

Globalstar and Roberson, through multiple filings over the last year, have yet to demonstrate or provide any evidence on the record of actual Iridium harmful interference. Instead, they have submitted multiple filings detailing academic and theoretical analyses based on extreme and unrealistic assumptions. In fact, many of the technical parameters used in the Roberson analyses are based on academic journal papers, rather than engineering data from Globalstar itself. Since both systems have been operating for 15 years, any sharing scenario analysis should consider real operational data from the two systems, including data relevant to the fact that the two systems have now been sharing nearly one megahertz of spectrum for eight years and up to over five megahertz of spectrum at various times when Iridium has been granted special temporary authority ("STA") by the FCC. It should be noted that these STAs have occurred during times of national and international disasters, when Iridium and Globalstar have shared spectrum under peak traffic loading conditions. At no time has Globalstar provided evidence that Iridium produces harmful interference in these sharing situations.

2. Technical Analysis

Roberson again attempts to show that sharing an additional 1.775 MHz of spectrum with Iridium will produce harmful interference to Globalstar and severely limit their per-satellite capacity. Each of these erroneous claims is examined below.

[1] *See* Roberson and Associates, *Reply to Iridium Ex Parte* (dated May 14, 2015) ("Roberson May 14, 2015 Reply") *attached to* Letter from Regina M. Keeney to Marlene H. Dortch, Secretary, Federal Communications Commission, RM-11697 (filed May 14, 2015) ("Globalstar May 14, 2015 Letter").

2.1 Claims of Harmful Interference

Iridium and Globalstar have provided a number of interference analyses, based on a wide range of system parameters and assumptions. Iridium has maintained that realistic loading scenarios show that its narrowband emissions are effectively mitigated by Globalstar's wideband spread spectrum signals and produce an increase to Globalstar satellite receiver noise-plus-interference levels of about 3%,[2] which is consistent with the value obtained from the ECC Report 95.[3]

Roberson's recent submission provides an updated interference analysis based on refinement of some of their original assumptions and parameters. Roberson has apparently: (1) confirmed Globalstar's satellite footprint size, (2) made assumptions about Iridium loading based on various Erlang B blocking levels, and (3) assumed a heterogeneous mix of Iridium services and user terminals based on voice and "short message" (presumably referring to Short Burst Data (SBD)) traffic. Although Iridium's traffic mix is more heavily biased towards the lower power SBD traffic and devices than Roberson assumes, the analysis now purports to show an Iridium-induced increase in noise-plus-interference of 11.9%.[4] This is in contrast to their previous analysis, which showed an increase in noise-plus-interference of 12.4%.[5] Although this analysis reveals a slight improvement in the amount of interference, it doesn't seem to offer any real new value to the discussion.

Iridium believes the assumptions behind Roberson's analysis are unrealistic. However, even if their analysis is accepted, Iridium maintains that this level of interference is in no way harmful or reason for precluding sharing a small portion of the band. An 11.9% increase in noise-plus-interference is an impact of approximately 0.5 dB (as opposed to 0.1 dB degradation due to 3% increase in noise-plus-interference claimed by Iridium[6]). This degradation of approximately 0.5 dB, within 2.725 MHz[7] of spectrum out of a total of 25.225 MHz of total user link spectrum, would have a minimal impact on Globalstar's system performance and be virtually undetectable from a user's perspective. Indeed, mobile satellite signals vary by more than this amount every second in a user terminal receiver. We know of no sharing situation in any frequency band in which:

1. Only two systems share, and in fact only share a small portion of the overall band, and
2. One system causing the other system a short-term degradation of approximately 0.5 dB to noise-plus-interference could even remotely be classified as "harmful."

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[2] Supplemental Comments of Iridium Constellation LLC, Exhibit 2 at 3-5, RM-11697, IB Docket No. 13-213, RM-11685 (filed Nov. 5, 2014) ("Iridium Nov. 5, 2014 Supplemental Comments").

[3] ECC Report 95, Sharing Between MSS Systems Using TDMA and MSS Systems Using CDMA in the Band 1610 – 1626.5 MHz, Bern, February 2007

[4] Roberson May 14, 2015 Reply at 5.

[5] Roberson and Associates, LLC, *Impact of Iridium Operations in 1616-1617.775 MHz on Globalstar Operations* at 11 (dated Jan. 14, 2015) *attached to* Letter from Regina M. Keeney to Marlene H. Dortch, Secretary, Federal Communications Commission, RM-11697 (filed Jan. 14, 2015).

[6] Iridium Nov. 5, 2014 Supplemental Comments, Exhibit 2 at 5.

[7] Iridium is currently proposing to share an additional 1.775 MHz in addition to the current 0.95 MHz, for a total of 2.725 MHz.

Lastly, as Iridium has commented previously, any claim by Globalstar that an approximately 0.5 dB increase in noise-plus-interference due to sharing with one other system in a small portion of its overall band should constitute harmful interference seems disingenuous given that Globalstar's system was designed and built under the assumption that it would share its entire L-band and S-band spectrum with up to three other wideband spread spectrum systems. Iridium demonstrated in its November 5, 2014 filing, that each of these other systems would produce more interference than Iridium and produce it across Globalstar's entire user link spectrum.[8]

2.2 Claims of Reduced Capacity

Roberson continues to claim that sharing an additional 1.775 MHz of spectrum (out of its 25.225 MHz of user link spectrum) will cause severe degradation in Globalstar's satellite capacity. Even with Roberson now stating that Globalstar satellites apparently have selectable, tunable filters in their transponders that can effectively mitigate Iridium emissions outside of the specific spectrum being used by Globalstar (which is inconsistent with previous filings), they still claim that Iridium emissions within the 1.775 MHz of additional shared spectrum reduce satellite capacity by anywhere from 20.9% to 31.3%, depending on Iridium traffic loading and voice/data traffic mix.[9]

This conclusion is based on completely unrealistic loading assumptions. Roberson assumes that the maximum number of Iridium users within 1.775 MHz in a single spot beam under high traffic loading conditions is 32.4.[10] They then assume that this high loading condition exists in all 48 Iridium spot beams, *i.e.*, throughout an Iridium satellite footprint that encompasses an area roughly the size of the continental United States and Mexico. Since the Iridium satellite automatically attempts to distribute traffic evenly across its frequency band, this would also mean that this high level of loading would also exist throughout Iridium's entire band. This would result in an amount of loading on the entire Iridium satellite that is not practical given satellite resources (and would also result in a satellite capacity several times greater than Globalstar's own claimed capacity of 2500 users per satellite).

A much more realistic heavy traffic loading scenario, such as during a natural disaster, would see a concentrated level of traffic over an area of several Iridium spot beams (each having a diameter of roughly 200-400 miles). Table 1 provides an estimate of number of Iridium users and subsequent impact on Globalstar satellite capacity, using past natural disaster scenarios as realistic reference points. The assumptions for impact on Globalstar capacity are taken from the Roberson analysis, which assumed that 1.81 Iridium users are equal to one Globalstar user.[11] The table shows that, even for large disaster recovery regions, a realistic amount of Iridium traffic in the shared spectrum would degrade Globalstar's overall capacity of 2500 users per satellite by less than 2%.

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8 Iridium Nov. 5, 2014 Supplemental Comments, Exhibit 2 at 3-5.

9 Roberson May 14, 2015 Reply at 4.

10 *Id.* at 3.

11 *Id.* at Appendix B.

Table 1: Iridium Traffic and Impact on Globalstar Capacity

Max Iridium users within 1616-1617.775 MHz and one spot beam	32.4	Per Roberson analysis, assuming 10% blocking
Max Iridium users within 1616-1617.775 MHz in "NA Service Area"	1205	11.9 million km^2 area, per Roberson analysis
Max Iridium users within 1616-1626.0 MHz in NA Service Area	6789	Multiply above figure by 10.0MHz/1.775MHz
Application of Above Assumptions to Various Disaster Scenarios		
Haiti earthquake area (km^2)	90,000	Conservative estimate (300km x 300km square area)
Max Iridium users (within 1616-1617.775 MHz) serving Haiti disaster area	9	1205 users per 11.9M sq km (from above) adjusted to 90,000 sq km for Haiti (i.e., 1205*90,000/11,900,000)
Equivalent number of Globalstar users	5	Roberson analysis, 1.81 Iridium users per Globalstar user (80%/20% voice/data mix)
Percent degradation in Globalstar satellite capacity	0.2%	Based on Roberson estimate of Globalstar satellite capacity of 2500 (i.e., 5/2500)
Hurricane Katrina area (km^2)	600,000	Conservative estimate (600km x 1000km square area)
Max Iridium users (within 1616-1617.775 MHz) serving Katrina disaster area	61	1205 users times ($600,000/11.9x10^6$)
Equivalent number of Globalstar users	34	Roberson analysis, 1.81 Iridium users per Globalstar user (80%/20% voice/data mix)
Percent degradation in Globalstar satellite capacity	1.3%	Based on Roberson estimate of Globalstar satellite capacity of 2500 (i.e., 34/2500)
Japanese Tsunami area (km^2)	750,000	Conservative estimate (500km x 1500km square area)
Max Iridium users (1616-1617.775 MHz) serving Tsunami area	76	1205 users times ($750,000/11.9x10^6$)
Equivalent number of Globalstar users	42	Roberson analysis, 1.81 Iridium users per Globalstar user (80%/20% voice/data mix)
Percent degradation in Globalstar satellite capacity	1.7%	Based on Roberson estimate of Globalstar satellite capacity of 2500 (i.e., 42/2500)

Iridium notes again that, under the original Big LEO band plan, the Globalstar system was designed and built to share with up to three other systems across Globalstar's entire L-band and S-band spectrum. Assuming Roberson's analysis is correct and that each of the other three systems had the same satellite capacity as Globalstar, Globalstar's satellite capacity would be reduced by 75% from its maximum of 2500 users. This dwarfs the amount of supposed capacity degradation from Iridium in a small portion of shared spectrum.

The claimed maximum Globalstar satellite capacity of 2500 users is based on the assumption that all users are duplex voice service terminal users, with no SPOT or simplex users.[12] Each satellite

[12] "Basic capacity calculation methods and benchmarking for MF-TDMA and MF-CDMA communication satellites," International Journal of Satellite Communications, 2004. This is the source for Roberson's capacity

should have a much higher capacity for simplex users, since these terminal emissions are lower power than voice terminals, are very short in duration (<1.5 seconds each), benefit from greater processing gain, and reside in frequency channels that are adjacent to the voice channels.[13] All of these factors should result in simplex services placing a far lesser constraint on the satellite transponder power amplifiers and making them more immune to any capacity reduction from Iridium emissions, relative to Globalstar duplex users. Whatever the actual potential impact on Globalstar duplex voice user capacity from Iridium emissions, the impact would be much smaller on Globalstar's most popular service – its simplex service.

Globalstar's claim that Iridium would seriously degrade system capacity also seems dubious when considering their system configuration and frequency plan. Over half of Globalstar's 24 gateways only support a single uplink channel.[14] If Globalstar is experiencing or even concerned about the impact of Iridium emissions in a small portion of its frequency band, it would be illogical to have most of their gateways only support one out of seven available uplink channels, which apparently is the case. Given these facts, it would be safe to assume that very low user traffic demand means that any additional gateway channels are unnecessary, further undermining the company's claims of capacity constraints.

Globalstar has also made the repeated claim that Iridium's proposal forces Globalstar users into the bottom four channels encumbered by the Radio Astronomy Service. However, as Globalstar has previously noted, Radio Astronomy Service protection zones make up a small overall percentage of Globalstar's coverage area (e.g., less than 16% of CONUS is covered by RAS exclusion zones).[15] It seems completely unrealistic that Globalstar cannot provide sufficient coverage to 16% of CONUS with three (channels 5, 6 and 7) of its seven L-band duplex service channels.

2.3 Additional Factors Inherent in Globalstar's System that Impact Interference and Capacity

There are a number of other factors that impact the assumed Globalstar interference and capacity degradation that the Roberson analyses have never considered.

- Multi-satellite coverage. No mention has been made of the fact that the vast majority of Globalstar's coverage area has visibility to multiple satellites, including many areas that are covered by three and even four satellites (for example, as illustrated in Figure 1, below, all of the continental United States is

(Continued . . .)
figure. Excerpted text: "User capacity of a LEO communications system in this paper is defined as the number of simultaneous voice duplex channels that a particular system can support."

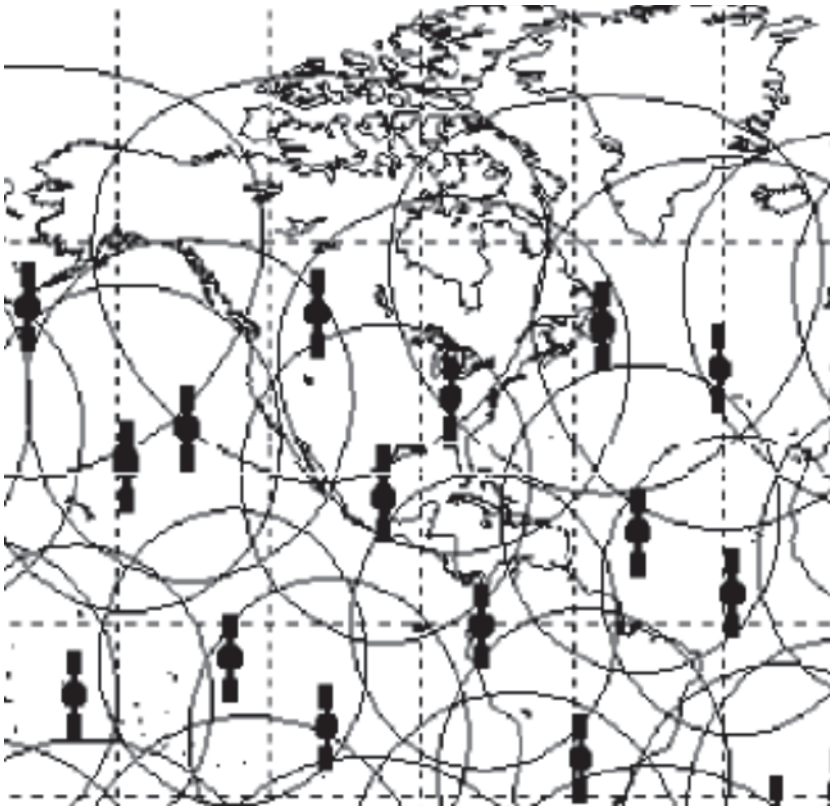
[13] Globalstar, Simplex Transmitter Unit, available at http://www.globalstar.com/en/docs/stx3/STX3%20Sell%20Sheet.pdf. See also http://productsupport.globalstar.com/2009/02/09/are-simplex-messages-secure/.

[14] Letter from L. Barbee Ponder IV, General Counsel & Vice President Regulatory Affairs, Globalstar, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission, Attachment at 16, RM-11697 (filed Oct. 6, 2014) (showing only one uplink channel being used in 13 of 24 Globalstar gateways)

[15] Opposition of Globalstar, Inc. to Petition for Rulemaking at 16, RM-11697 (filed Dec. 2, 2013).

covered by at least two satellites).[16] Multi-satellite diversity and coverage improves user availability and provides support for greater capacity. Even in concentrated areas, not all users have the same line-of-sight geometry to the nearest satellite(s) and thus may take advantage of being able to communicate with multiple satellites, including different satellites with additional capacity in many cases. In fact, Globalstar documents state that on the return link, "the noise backgrounds in which they are received are essentially independent."[17] This provides diversity and mitigation against any additional external interference.

Figure 1: Typical Globalstar Coverage of CONUS[18]



- Globalstar's capacity is forward link limited. Globalstar's own system description also states that its system capacity is limited by the forward link (*i.e.*, the 2.4 GHz spectrum link from satellite to user): "In the forward direction,…this is the direction that constrains capacity."[19] Therefore, since Globalstar concedes

[16] Globalstar, L.P., *Description of the Globalstar System* at 3-8, GS-TR-94-0001 Revision E (Dec. 7, 200) *available at* https://gsproductsupport.files.wordpress.com/2009/04/description-of-the-globalstar-system-gs-tr-94-0001-rev-e-2000-12-07.pdf ("Globalstar System Description).

[17] *Id.*, 4-2

[18] *Id.*, 3-7.

[19] *Id.*, 4-14.

that capacity is limited by forward link limitations, then any discussion of Iridium impact on reverse link (1.6 GHz spectrum) degradation seems moot.

- Soft capacity. Globalstar's system is designed to support soft capacity: "Since CDMA is basically a system whose capacity is limited by self-generated interference, the limit is a soft limit. Unlike bandwidth limited systems…, CDMA allows the predicted capacity limit to be exceeded with soft degradation occurring."[20] This means that in brief periods of high user traffic (or, as claimed by Roberson, when capacity is being usurped by Iridium), the Globalstar system can accommodate higher capacities by accepting some degradation in signal quality or lower vocoder rate for instance.

[20] *Id.*, 4-1.